Electromagnetic Engineering (EC21006)
Mid Semester Examination
Department of Electronics and Electrical Communication Engineering

Full Marks : 80
Time – 2 hrs

Answer all questions. The marks for the individual questions are indicated on the right.

1. Express the vector

$$\vec{B} = \frac{10}{r}\hat{a}_r + r\cos(\theta)\hat{a}_\theta + \hat{a}_\varphi$$

in the Cartesian and the Cylindrical coordinates. Evaluate $\vec{B}(-3,4,0)$ in the Cartesian coordinate system and $\vec{B}(5,\pi/2,-2)$ in the Cylindrical coordinate system.

[7+7+3+3=20]

2. In a nonmagnetic medium, a propagating electric field is given by the following expression :

$$\vec{E} = 4\sin\left(2\pi\times10^7 t - 0.8x\right)\hat{a}_z \quad V/m$$

Evaluate the following :
(a) The relative permittivity ε_r and the intrinsic impedance η of the medium:
(b) The time average power carried by the wave.
(c) The total power crossing 100 cm^2 of the plane $2x + y = 5$.

[5+5+10=20]

3. A uniform plane wave propagating in a medium is described by :

$$\vec{E} = 2e^{-\alpha z}\sin\left(10^8 t - \beta z\right)\hat{a}_y \quad V/m$$

If the medium is characterized by the parameters $\varepsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3\,mhos/m$, evaluate α, β and the magnetic field $\vec{H}$.

[4+4+12=20]

4. Prove and explain the power conservation theorem for time-harmonic electromagnetic fields.

[20]